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MATERIAL FOR POWDER METALLURGY

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/Following is the translation of an article by I. L. Bartashev in Tsvetnyye Metally /Nonferrous Metals/, No. 3, March, 1961, pages 82-86./

In modern industry it is difficult to name a field in which one or another article or material obtained by the powder-metallurgy method is not widely employed or at least tested. This branch of metallurgy provides the enterprises of the machine-building, transportation and mineral-processing industries with hard, wear-resistant materials; the chemical instrument and aircraft factories with heat-resistant and fireproof materials; the electrotechnical and electrovacuum branches of industry with materials having remarkable semiconductor properties; the objects of automated welding with special materials and details; etc. (1).

Metalloceramic articles of tungsten, molybdenum, tantalum and other high-melting metals have found wide use in the electric-lamp and electric-vacuum industries.

Thus, tungsten and molybdenum are used as materials which provide hermetic welding with glass under high-vacuum conditions, while tantalum, niobium, zirconium and thorium are employed in vacuum techniques as getters in the form of thin coatings on the inner surfaces of equipment operating under high-vacuum conditions (2).

Since the War, the industry which produces metalloceramic articles on an iron-powder base for such branches of industry as metal working, machine building and drilling has undergone special development. Hard metalloceramic alloys containing in their composition various combinations of tungsten and cobalt carbide have also found wide use in these branches of industry. Among them are the alloys of the "Pobedit" type, the "VK" group of alloys (VK-3, VK-15) and others.

However, owing to the deficiency of tungsten and cobalt, as well as to the necessity of creating a tool suitable for the highly productive working of very resistant and tough materials which are difficult to work, new compositions of universal alloys have been worked out.

Among such alloys are the alloys with boride bases. Thus, the "American Electro-Metal Corporation" manufactures a cutting tool of borides made up of molybdenum, nickel and boron. This material gives good results in cutting work, and possesses sufficient hardness and resistance to bending. The heat conductivity of this material approaches the hard

"tungsten-cobalt carbide"alloys (3).

Also we know of the use, in contact techniques as well, of a large number of compositions from metallic and non-metallic (having carbide or boride bases) powders of metals. Among these may also be classed such compositions as tungsten-copper, tungsten-copper-nickel, tungsten carbide-silver, cobalt (osmium-copper)-tungsten boride-graphite, silver-nickel-cadmium, silver-iron, gold-graphite and others.

The greater use of metalloceramic contacts by comparison even with such metals as copper and silver and, in certain cases, gold and platinum, may be explained by their high thermal resistance, their high mechanical strength, their great reliability in operation and long serviceability of electric apparatus with metalloceramic contacts; at the same time they give considerable saving in expensive metals. Possessing a low friction coefficient, better capacity for being broken in, and great resistance to wear, metalloceramic articles have found wide employment also as antifriction material in transportation, machine building, motor and instrument manufacture. Compositions such as iron-graphite, copper-lead, copper-lead-graphite, copper-zinc, copper-zinc-graphite and others are usable as ordinary metalloceramic antifriction materials.

The methods of powder metallurgy can also produce materials with previously designated porosity or with communicating pores, which promotes good permeability by gases and liquids.

The following properties have been widely used in industry for manufacturing:

1) Various articles of porous antifriction materials--porous bearing bushings in automobiles and airplanes, bearings of railroad cars, small bushings of textile machines, tec., which possess the property of self-lubrication in addition to high antifriction properties. Among the porous bearings turned out in the USSR may be mentioned: iron ores with 10-30% porosity, iron-graphite ones with 20-30% porosity, bronze-graphite ones with 20-30% porosity, etc.

2) Metalloceramic filters with great strength, satisfactory toughness and good resistance to impact stresses. Such filters are used to purify aircraft and automobile fuel of suspended mechanical particles, to filter compressed gases in jet motors, to filter various liquids, gases and air in a number of fields of the chemical industry (4). Widely used as materials for the manufacture of metalloceramic filters are various grades of fineness of powdered bronze, nickel, iron, stainless steel (brands 18/8, 18/12 and others) and silver, as well as powdered carbides of high-melting metals of the IV, V and VI groups of the periodic table of elements.

3) Porous materials used because of their plasticity and pores for producing sealing packing, porous electrodes, fillings, etc. Among this type of materials may be classed bituminized iron "zinterit", manufactured from coarse iron powder baked at 1200-1350° and saturated (up to 15% of the weight of the article) with bitumen.

It is interesting to note also the use of powdered aluminum as the basic raw materials for the production of fireproof materials.

The recently developed new method of producing fireproof materials on a bse of "SAP" aluminum (baked aluminum powder) has made it possible to create alloys possessing: mechanical strength exceeding that of pure aluminum and the alloys "Avional'" (Al-Cu-Mg) and "Igrek" (Al-Cu-Ni); increased hardness (about 90 kg/mm^2); a high melting point, lying about 150° higher than that of the well-known aluminum piston alloys.

All this makes it possible to use "SAP" at relatively high temperatures and therein obtain considerable savings of materials by manufacturing only insets of "SAP" instead of whole solid pistons. The high heat resistance of "SAP" has gained employment for it as a material for manufacturing compressor blades (2).

In a number of cases in comparing the profitability of using cast metals or metalloceramic articles, the decisive role is played by economy. By using metalloceramic articles indtead of the ordinary (cast) parts, one achieves great savings of metal and material expenditures.

Thus, I. N. Frantsevich (1) cites, among a number of examples in the economic efficiency of using metalloceramic articles in technology, the following data on the employment of bimetallic diesel-motor bearings (per unit):

	By usual method	By powder-metallurgy method
Basic material	Lead bronze (cast), BRS30	Powdered copper and lead
Expenditure of materials, in kg	11.32	3.2
Labor, in hours	9.1	6.3
Cost, in rubles	28.8	11.0

Thus, it may be seen that by using the powder-metallurgy method the enterprise will realize a direct saving of 71% in materials as against the usual method, a reduction of labor used in manufacturing by 2.8 hours and a saving of 17.8 rubles in the cost of making the article.

All this testifies convincingly to the profitability of introducing on a wide basis articles made by the powder-metallurgy method into the most varied branches of industry.

However, it seems to us that not all the possibilities have yet been exploited even in this promising branch of industry.

Lately, because of the development in the production of metallic titanium, pseudo-alloys with a titanium carbide base in composition with nickel, tungsten, chromium, cobalt, tantalum, vanadium or molybdenum have begun to find use as fireproof metalloceramic materials serving at temperatures of 980-1200° (5).

The introduction of carbides of titanium, tantalum, niobium, vanadium and other metals into the composition of the hard metalloceramic alloys of the "tungsten carbide-cobalt" type improves the properties of the alloys. Thus, the introduction of titanium carbide into the composition

of hard alloys instead of a part of the tungsten carbide (alloys of the "TK" type) reduces by 1.5 to 2 times the propensity to oxidation when heated and sharply diminishes the sticking of the alloy to the shavings.

A similar action on the properties of alloys is also exerted by adding to the alloys other carbide-forming elements: the carbides of niobium, tantalum, tungsten, etc.

V. N. Yeremenko's monograph (5) gives a large number of compositions of hard alloys having a titanium base with the above-listed metals. For example, in the USA wide use as fireproof alloys having a titanium carbide base has been found for alloys in which from 10 to 30% Ni (alloys of the brands K150A, K151, K151A, K152B, K152) or from 5 to 30% Co (alloys of the brands K138A, K139A, K140A and K141A) are used as bond.

V. N. Yeremenko, examining the comparative data on the performance of metalloceramic alloy of the K151A type with the fireproof metallic alloy of the "Nikonel'-Kh" type, points out that at 870° the strength of alloy K151A surpasses that of "Nikonel'-Kh" by 1.7 times, and a part made of alloy K151A under the same conditions (at 870°) will perform about 10,000 times longer than a part made of the alloy "Nikonel'kh."

In the Soviet Union, alloys with a titanium carbide base (T5K10, T5K7, T14K8, T15K6 and T30K4) have found employment as hard-alloy cutting tools or in their pure form as abrasives (both powdered and in cemented form).

However, in spite of a certain amount of industrial use, though thus far extremely limited, of titanium carbide, the powdered metallic titanium obtained as waste in finishing titanium bloom in the process of obtaining forgeable metallic titanium has thus far not yet become properly widespread as a metalloceramic material.

Some theoretic studies are now being made in this field by the Institute of Metalloceramics of the Ukrainian Academy of Sciences (Kiev) under the direction of corresponding member of the Ukrainian Academy of Sciences, Professor I. N. Frantsevich.

On the basis of titanium powder obtained by the hydride-calcium method, the laboratory of metalloceramics of the "TsNIIChM," /Central Scientific Research Institute of Ferrous Metallurgy/ has been working on the manufacture of metallic tape by the method of pressing and cold-rolling the powders.

However, not enough work is as yet being done on the problem of the use of metallic titanium powder in technology. This can probably be explained by the nearly total lack of literature on titanium powder metallurgy.

The wide use of metallic titanium in aircraft manufacture, both in the form of pure metal and in that of alloys, in high-vacuum technology as a getter, as well as in shipbuilding and chemical instrument manufacture, is promoted by the remarkable properties of this metal as a very strong (especially at high temperatures), corrosion-resistant, chemically stable and plastic material, easily subjected to mechanical working. Metallic titanium powder also possesses these same properties to a considerable degree.

It is known that, as a result of the application of the classic magnesium-thermal method for reducing titanium tetra-chloride (the Krol process), as much as 20% fine titanium grit is formed alongside of the bulk of titanium sponge.

Its size ranges from very fine (powder of the size of 0.25 mm or less) to grains 1 + 3 mm /sic./ in size.

It may be assumed that a considerable amount of this material can be used as material for producing metalloceramic articles, such as bushings on shafts of screw propellers of seagoing vessels, impellers of mixers in chemical instruments, fittings and flanges in pipelines operating in corrosive media, etc.

In favor of the manufacture of these parts by one of the methods adopted in powder metallurgy is the fact that the manufacture of parts from titanium by casting in a vacuum or in an inert atmosphere is technically rather complicated because of the high chemical activity of the molten titanium with respect to hydrogen, nitrogen and oxygen. Later the parts must be mechanically treated; this step is practically eliminated when the methods adopted in metalloceramics are used.

S. Abkovits, J. Burke and R. Khilts, examining the possibility of using metallic titanium powder for purposes of powder metallurgy (6), consider that in time this method may come to occupy an important place in the titanium industry.

Reporting that both sponge and scrap may be a possible raw material for the procurement of titanium powder, the authors note that so far there are still extremely limited fields of use of titanium powder; they point out that titanium carbide may be used in the production of cutting tools and that titanium may be added to the compositions of various refractory materials.

However, even in such a specialized monograph on titanium as that mentioned above, there are no indications of the fields for the use of parts made from titanium and manufactured by the powder-metallurgy method. This once more emphasizes the insufficient attention paid to titanium as a material for metalloceramics.

A no less important factor affecting the choice of method of making this or that article is the savings on production expenditures.

It may be assumed that, in the case of the manufacture of parts from titanium by metalloceramic methods, the process of their production will be more economical than in the production of the same parts by casting metal, the more so because, in powder-metallurgy practice, wide use can be made of wastes from the basic production of titanium; the price of this even now is many times less than the cost of cast metal.

The mastery by our own industry of the technology of the electrolytic refining of the wastes of industrial titanium and alloys, which use shavings from stripping titanium ingots or scrap from rolling, will make it possible to obtain fine and very cheap powder homogeneous in chemical composition, possessing high mechanical properties and entirely suitable, in our opinion, for metalloceramics.

A tentative economic estimate shows that a ton of titanium powder obtained by the electrolytic refining of titanium or titanium-alloy

wastes will be 3-5 times cheaper than a ton of titanium sponge, to say nothing of the cost of ingots of cast titanium; and the quality of the powder will probably satisfy the demands upon sponge titanium of high grades under the now-existing technical conditions.

All this points to the necessity of a comprehensive expansion of the volume of scientific-research work in the field of the metalloceramics of the powders of titanium or alloys having it as their base, as well as of extensive experimental work on the elaboration of the technology in the manufacture of parts from titanium powder and the testing of them in the various branches of the country's national economy.

It seems to us that the time has come to solve the question of co-ordinating the work in the field of titanium metalloceramics and to conduct it according to a unified plan.

The benefit from a positive solution of this problem is obvious, the more so because great significance is attached in the prospective Seven Year Plan for the development of the national economy to the further development and improvement of titanium metallurgy.

For this reason, it seems to us necessary, in the shortest possible time, to solve the questions of the organization of broad research in the field of titanium metalloceramics in order to give our industry, in the very near future, a new promising metalloceramic material, the use of which will contribute to the further raising of the technical level of our native science and technology.

LITERATURE

1. Frantsevich, I. N., Poroshkovaya metallurgiya /Powder Metallurgy/, "Znaniye" Publishing House, Series IV, No 34-35, 1958, p. 5.
2. Ayzenkol'b, F. Poroshkovaya metallurgiya, Metallurgizdat, 1959.
3. Vyaznikov, N. F. Yermakov, S. S., Primeneniye izdeliy poroshkovoy metallurgii v promyshlennosti /The Use of Articles Made by Powder Metallurgy in Industry/, Mashgiz, 1960, p. 145.
4. Agte, Kurt and Otsetek, Karel, Metallokeramicheskiye fil'try, ikh izgotovleniye, svoystva i primeneniye /Metalloceramic Filters, Their Manufacture, Properties and Use/, Sudpromgiz, 1959.
5. Yeremenko, V. N., Karbid titana i zharostoykiye materialy na yevo osnove /Titanium Carbide and Fireproof Materials Having it as a Base/, Publishing House of the Ukrainian Academy of Science, Kiev, 1954.
6. Abkovits, S., Burke, J., and Khilts, R., Titan v promyshlennosti /Titanium in Industry/, Oborongiz, 1957.
7. Bal'shin, M. Yu., Poroshkovaya mettalurgia, Mashgiz, 1948.
8. Tsukerman, S. A., Poroshkovaya metallurgiya i yeye promyshlennoye primeneniye /Powder Metallurgy and Its Industrial Use/, Publishing House of the Academy of Science, USSR, 1949.

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